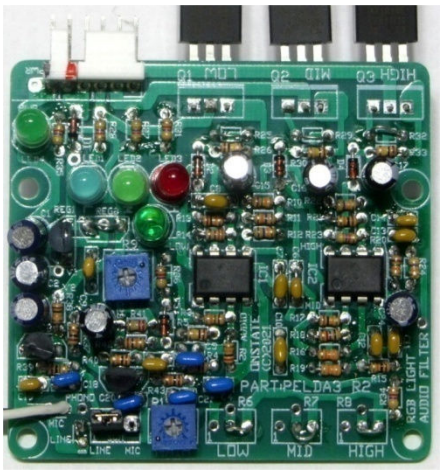
Audio Band Spectrum Filter Module



Description:

The LDA3 module is a DIY kit for audio band spectrum filtering. Three active filters are used to separate the audio signal into low (low pass), mid (bandpass) and high (high pass) bands. The filtered outputs can be connected to an RGB LED strip to give a visual beat/intensity of the music (AKA colour organ/light organ) in different colours and intensity. The three filtered audio signals also work as an audio crossover filter or tone control (bass, midrange, treble) or used into a DSP for further audio processing. The audio source can be from a line level source or earphone or from its built-in microphone circuit with automatic level limiting.

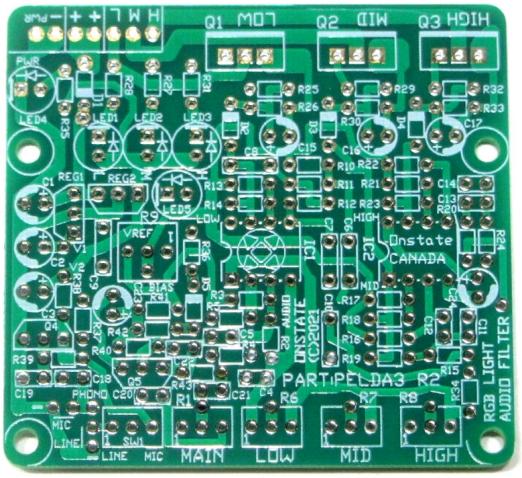
Circuit Operation:

The audio input is first amplified and level limited before going to each filter. Variable resistor R1 (MAIN) is used to adjust the signal level into the amplifier and AGC level limit circuit. The amplified audio is passed through the low-pass (LOW), band-pass (MID) and high-pass (HIGH) filters to separate the input audio. The individual band signals can go into another audio processor or DC rectified to modulate the MOSFETs for a flashing/strobing effect. Variable resistor R9 (BIAS) is used to adjust the MOSFET output levels for the LEDs to be glowing or off with no music input. The module is designed for use with 12VDC RGB or individual LED strips at 0.5A for each band or higher with heatsinks mounted.

Optional: The unit has an optional microphone circuit for sound input. A SPDT switch (SW1) can be used to select LINE or MIC input. Variable resistors R6 (LOW), R7 (MID) and R8 (HIGH) can be used to individually adjust each band intensity level for audio tone control. Omit AGC level limit (Q5) for high linearity audio.

Technical Specifications:

Dimension:	65mm x 61mm (2.56”x2.40”)
Operating voltage:	12V nominal (10V - 14V) 24V (20-28V) LED strips
Band output current:	30mA per channel (op-amp).
Standby current:	<15mA.
Audio input level (min):	100mV, gain adjustable.
Audio input level (max):	2V RMS.
Microphone input.	Electret, pre-amp.
LED current:	N-CH MOSFET 0.5A (per band). Common +.
PCB:	1/16” FR4, RoHS, HASL. 2-layers through-hole plated

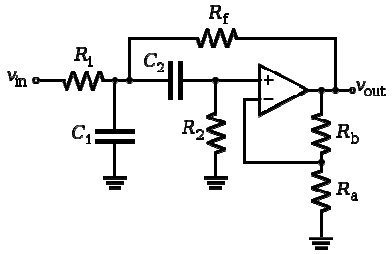


Filter Response (-3dB output measured)
Low pass: 40-290Hz (110Hz). Input RC limit low freq.
Band pass: 1000Hz (320Hz - 2900Hz)
High pass: 3100Hz, 10kHz (full), op-amp bandwidth limits maximum frequency.
NOTE: BOM sets filters around the audio voice band range.
Bass=16-256 Hz. Voice=300-3000kHz. Treble=2.0-16kHz.

Filter Band Calculation:
The pass filters are based on Sallen-Key RC filter circuit topology.
Internet seach Sallen-Key filters for more technical information and design.
See schematic for design information.

Low and high pass filters:
Center frequency (-3dB)
$f_o=1/(2\pi \text{ sqrt}(R_1R_2C_1C_2))$
Gain=$1+R_b/R_a$
Q=Quality factor($f_o/\Delta F$)
Keep G<3.
Bandpass filter:
f_o=center frequency

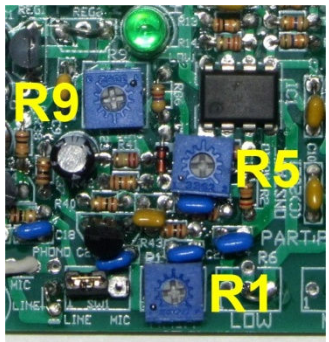
$$f_0 = \frac{1}{2\pi}\sqrt{\frac{R_f + R_1}{C_1 C_2 R_1 R_2 R_f}} \qquad Q = \frac{\sqrt{(R_1 + R_f)R_1 R_f R_2 C_1 C_2}}{R_1 R_f (C_1 + C_2) + R_2 C_2 (R_f - \frac{R_b}{R_a} R_1)}$$



Assembly:
The user should have basic soldering and troubleshooting skills. Basic equipment such as a soldering iron and a digital multimeter are also required. All parts are through-hole assembly.
See LDA3 bill of materials (BOM) and schematic for component selection for options. The BOM list has priority over schematic parts values. The microphone circuit and adjustment resistors (R6,R7,R8, use wire jumpers) are not required for line-level or eaphone input signals. Capacitor leads can be bent for 0.1" or 0.2". LED1-3 are optional. Do not omit REG2 if the microphone circuit is used. Isolate output MOSFETS from ground and each other.

Setup

1. Check components to match parts listing. Use a multimeter to check resistor values if required.
2. Check the PCB layout and know where the parts are placed.
3. Solder wires or connectors to circuit board layout "H M L + PWR LINE" connections. The band outputs are common positive to the LEDs. Recommended LED colors: blue for low, green for mid, and red for high. If preferred, other LED colors can be used for the outputs.
4. Apply +12V power to circuit board POWER IN. Check power LED4 (PWR) is on.
5. Turn R9 (BIAS) variable resistor all towards LED5 side. Output LEDs (LOW, MID, HIGH) should be off. Turn R9 until all LEDs are just on. Note: R9 adjusts the bias level of the MOSFETs to set the minimum output level. Adjust R9 to set the LED ambient level if required.
6. Adjust R1 (MAIN) for volume brightness control. R1 usually set at maximum (CW).
7. Apply line level audio input to LINE IN. R1 sets sensitivity and averally response and brightness.
8. The LEDs should be pulsing to the beat/loudness of the music.
9. A resistor/capacitor load/filter can be directly soldered onto the line-in or microphone wires to reduce excess noise. This will make the outputs have less unwanted signal if the input is noisy from long cables or has static noise.



Trimmer resistors. R1=input level. R9=output bias. R5=gain adjustment.